POLICY APPROACHES TO ENERGY USE REDUCTION IN TENANT SPACES

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Table of Contents

Abstract

A significant focus of climate policy in the United States is on energy use in buildings because buildings account for approximately 40% of GHG emissions nationwide. Many local governments have created policies that regulate energy use in buildings but tenant spaces are often excluded from these efforts. Untapped potential exists to reduce energy use within building tenant spaces, which can account for up to 50% of a building's energy use. In order to reach the aggressive GHG emission reduction goals set by scientists and governments in order to avoid the most harmful effects of climate change, all possible avenues of energy reduction are of interest. However, there is no clear understanding of how local governments are attempting to reduce energy usage in tenant spaces.

The aim of this research was to understand the approaches that local governments have used to influence energy use in tenant spaces through both mandatory policies and voluntary programs. Additionally, this research aimed to understand the impetus and barriers to policy creation and implementation regarding private tenant spaces. This study utilized two research methods: 1) review of policy documents and 2) interviews with selected city officials and industry experts. The research focused on cities participating in the C40 program, specifically within the Private Building Efficiency Network.

Detailed policy maps provide an overview of approaches taken and highlight where opportunity exists for innovative, new policy types. Few mandatory policies were found within sampled cities. Most cities provide a multitude of programs that foster the voluntary reduction of energy use in tenant spaces by providing resources and incentives to tenants. The most common of these programs is providing educational resources and green leasing assistance. While there is consensus among experts and city representatives that reducing tenant use is a common and complex problem, there is no consensus as to how government can best respond to this issue. Many barriers exist in creating and implementing such policies and programs leading most governments to focus on other aspects of building energy use or relying on voluntary programs.

Knowledge sharing between cities is a particularly valuable tool when lessons are paired with an understanding of city-specific barriers and opportunities. This approach enables policy makers to craft effective policies and programs to address the largely untapped potential that exists to reduce energy use within building tenant spaces.

I. Introduction

As the impacts and causes of climate change are becoming more certain and apparent, the urgency of the problem has led many governments across the globe to adopt greenhouse gas emissions (GHG) emission reduction goals and pursue climate action plans. The governmental approaches to address climate change largely have focused on reducing energy use from fossil fuels through efficiency improvements and conversion to non-fossil fuel based energy sources. A significant focus of climate policy in the United States is on energy use in buildings because buildings account for approximately 40% of GHG emissions nationwide.[1] Similar trends are seen across the globe.

Untapped potential exists to reduce energy use within building tenant spaces.[2] Avoiding the regulation of tenant spaces ignores a significant amount of GHG emissions that could be reduced. The US Department of Energy estimates that leased spaces represent approximately 50% of a commercial building's overall energy use.[3] Many governments have created policies that regulate energy use in buildings but tenant spaces are often excluded from these mandatory policies. Tenants have received little pressure or support from government to voluntarily reduce energy use within their private spaces. In order to reach the aggressive GHG emission reduction goals set by scientists and governments, all possible avenues of energy reduction are of interest. However, there is no clear understanding of the most effective governmental approach to reduce energy usage in tenant spaces.

[1] U.S. Energy Information Administration, Monthly Energy Review, October 2016, page 31.
[2] U.S. Department of Energy, *Energy Efficiency in Separate Tenant Spaces- a Feasibility Study,* April 2016, page 1.
[3] Ibid., 2.

The aim of this research was to understand the approaches that local governments have utilized to influence energy use in tenant spaces through both mandatory policies and voluntary programs. Additionally, this research aimed to understand the impetus and barriers to policy creation and implementation regarding private tenant spaces. The compilation and analysis of existing policy approaches can inform policy makers of potential paths to pursue or to avoid. It can also provide them with a better understanding of existing tools and mechanisms that can be leveraged to overcome the barriers that have made regulating tenant spaces a challenge. Knowledge sharing between governments of best practices in designing, implementing, and evaluating policies will lead to quicker adoption and success of similar policies in additional places, and ultimately will lead to fewer GHG emissions and less intense climate change.

New York City was used as a case to understand why these policies are important to climate change mitigation, what the city has implemented thus far, and why more has not been done. This approach was taken because New York City has publically recognized energy use in tenant spaces as a weak point in its existing policies and expressed a desire to pursue such policies and programs. In New York City, commercial tenant spaces can account for an estimated 40-60% of a building's overall energy use, which is 12-18% of citywide energy use.[4] The City government has a suite of mandatory policies and voluntary programs that address total building energy use. These policies, however, do not effectively reduce energy use from tenant spaces.

[4] The City of New York, *OneNYC: The Plan for a Strong and Just City,* 2015, Page 122.

II. Background

Cities play a crucial role in the global efforts to address climate change through mitigation and adaptation. City-level action is key in the fight against climate change because cities have the potential to make significant emissions reductions, the incentives to do so, and the political and practical capacity to make those changes.

Cities are major contributors to climate change, consuming 78% of the world's energy and producing 60% of the world's carbon dioxide emissions.[5] This portrays the immense potential that exists for cities to impact GHG volumes in the atmosphere. Additionally, while climate change is a global issue, the effects are felt locally. Nine of every ten major metropolitan areas are situated on waterways and are particularly vulnerable to sea-level rise and extreme weather events due to climate change.[6] Mayors and local level officials see the co-benefits to their city of reducing emissions such as cleaner air and healthier citizens. This incentivizes city officials to be proactive and push for stronger climate policy. Lastly, cities are uniquely positioned to make these changes. Cities often have jurisdiction over the main contributors to GHG emissions such as waste systems, transportation systems and buildings.[7] There are fewer bureaucratic hurdles to pass legislation and begin new programs that must be overcome on a local level that often exist at the state or national level. For these reasons, city-level policy on GHG emissions is increasingly important.

Energy use in buildings is of particular importance in curbing city GHG emissions and is a main focus of city-level climate action. In the United States, about 40% of emissions can be

[5] UN Habitat, *Climate Change*, http://unhabitat.org/urban-themes/climate-change/, (accessed February 20, 2017).
[6] Innovation Network for Communities, *Leadership by U.S. Cities: Innovations in Climate Action,* March 2016.
[7] Ibid.

attributed to energy consumed in buildings.[8] C40, a network of cities committed to addressing climate change, brings together cities to "collaborate effectively, share knowledge and drive meaningful, measurable and sustainable action on climate change".[9] A study of all cities that are a part of the C40 network reports almost half of city emissions are attributed to building energy use.[10] Additionally, building energy efficiency is one of the most prominent sectors (20%) of climate related political activity within the C40 cities.[11] Energy policies that focus on buildings have progressed from pilots into full programs or policies more than other energy consuming sectors[12]. While city-level climate action is often focused on buildings, tenant spaces are regularly excluded from scope.

A report was completed by C40, in conjunction with the Tokyo Metropolitan Government, titled *Urban Efficiency: A Global Survey of Building Energy Efficiency Policies in Cities.*[13] This report conducted interviews with a subset of C40 cities that have committed themselves to targeted work on energy efficiency in private buildings. The majority of city officials who participated stated that they are interested in learning more about and pursuing policies that target tenant engagement. They acknowledged that regulating tenant spaces was a particularly challenging issue.

New York City, a city within the C40 network, is particularly concerned with the unregulated energy use in tenant spaces. Since the creation of *PlaNYC*, New York City's initial sustainability strategy, in 2007, the city has emerged as a world leader in climate change policy.

[8] U.S. Energy Information Administration, op.cit., page 31.
[9] C40 Cities, *About*, http://www.c40.org/about, (accessed January, 27, 2017).
[10] T. Takagi, et al. "Urban Efficiency: A Survey of Building Energy Efficiency Policies in C40 Cities" Tokyo Metropolitan Government Bureau of Environment and C40 Cities Climate Leadership Group (2014).
[11] Ibid.
[12] Ibid.
[13] Ibid.

This is due to the aggressive goal the city set to reduce GHG emissions and also the comprehensive and innovative nature of the city's policies and programs on climate change. In order to achieve these goals, a collection of policies were created to address GHG emissions from buildings. These policies focus mainly on base building systems rather than tenant spaces and place responsibility for compliance on the owner rather than the tenant.

New York City's initial sustainability strategy was created in response to multiple challenges and opportunities recognized by then-Mayor Michael Bloomberg.[14] These challenges included a large projected population growth, aging infrastructure unable to meet this added capacity, and the threat of climate change. *PlaNYC* leveraged these stressors as an opportunity to strategically put forth policies and programs that address economic development and environmental sustainability. One outcome of *PlaNYC* was a goal to reduce GHG emissions by 30% by 2030, based on 2005 levels.[15] This plan was updated after Hurricane Sandy in 2012 to reflect new challenges of resiliency and the new understanding of the urgency of mitigating climate change. In 2013, by the end of the Bloomberg administration, GHG emissions had decreased 13% from 2005 levels.[16]

In 2015, under Mayor Bill De Blasio, the climate goals set forth in *PlaNYC* were strengthened and expanded in a plan titled *OneNYC*. Most notably, *OneNYC* increased the city's GHG emission reduction goal to 80% reduction by 2050.[17]

Under both *PlaNYC* and *OneNYC*, policies were created to reduce energy usage in buildings. This set of policies is titled the "Greener, Greater Buildings Plan". Buildings are a main

[14] The City of New York, *PlaNYC: A Greener, Greater New York,* 2007.
[15] Ibid., page 13.
[16] The City of New York, *PlaNYC: Progress Report 2013,* 2013, page 6.
[17] The City of New York, *OneNYC: The Plan for a Strong and Just City,* 2015, Page 6.

focus because the energy used in the city's buildings is the main end use of energy that leads to GHG emissions. In 2007, buildings contributed 79% of the total emissions.[18] In 2013, buildings contributed 71%.[19] From 2005 to 2014 GHG emissions from energy used in buildings decreased by 12.6 percent or 5.2 $MtCO_2e$.[20] Existing policies are largely limited to the base building systems and require compliance from the owner. Base building systems are those that are operated and maintained by the owner rather than by tenants or condo/coop unit owners. [21] Examples include the building envelope, HVAC (heating, ventilating, and air conditioning) systems, conveyance systems, domestic hot water systems, and electrical and lighting systems. Policies that require owners of large buildings to upgrade certain building systems to reduce energy use include lighting upgrades (Local Law 88), retro-commissioning (Local Law 87), and sub-metering (Local Law 88). Energy and water benchmarking (Local Law 84) and energy auditing are also required (Local Law 87). Additionally, the city required building owners to phase out the heating fuels with highest GHG emissions: oil numbers 6 and 4.

Current mechanisms to reduce energy in tenant spaces are voluntary and elective programs (rather than mandated) or policies where compliance is the responsibility of the owner. In 2007, the City created the Carbon Challenge, a platform for the private sector to pledge to voluntarily reduce their building-based emissions by 30 percent or more over 10 years. [22] The Carbon Challenge cohorts in the program include hospitals, universities, hotels, commercial buildings, and multifamily buildings. In 2017, the Carbon Challenge Program

[18] The City of New York, *PlaNYC: A Greener, Greater New York,* 2007, page 9.
[19] The City of New York, *One City Built to Last*, 2014, Page 22.
[20] The City of New York, *Inventory of New York City Greenhouse Gas Emissions: April, 2016,* page 26.
[21] The City of New York, Local Law 87.
[22] New York City Mayor's Office of Sustainability Green Buildings and Energy Efficiency, http://www.nyc.gov/html/gbee/html/challenge/nyc-carbon-challenge.shtml, (accessed November, 10, 2016).

expanded to include a platform for tenants and commercial owners. The commercial owner-tenant program aims to bring the two parties together to acknowledge and work towards common goals.

Policies do exist that regulate certain aspects of tenant space energy use that are aimed at owners; however no mandatory action from the tenant is required. Local Law 88 requires that owners of buildings over 25,000 square feet provide commercial tenants that occupy spaces larger than 5,000 square feet with energy submeters and lighting upgrades. Providing tenants with submeters allows tenants to know the amount of energy they use each month.

City policy makers later recognized that existing policies were insufficient to reach the 80% reduction goal by 2050. In a report titled *New York City 80x50 Buildings Technical Working Group Report* from April 2016, a group of policy makers, stakeholders, and industry experts analyzed current conditions and modeled future scenarios to better understand the steps necessary to achieve the 80% goal. The report led to the creation of a "roadmap" of strategic initiatives and policies that address energy, buildings, transportation, and waste systems.

One main finding from this report was that "tenant energy use and other unregulated loads in tenant spaces must be addressed to comprehensively reduce building-based energy use". [23] Tenant energy use is a sizeable portion of building energy consumption. Commercial tenant spaces can account for 40-60% or more of a building's overall energy use in New York City.[24] Similarly, nationwide, leased spaces represent approximately 50% of a building's overall energy use.[25] The Technical Working Group Report noted that existing policies that do not focus

[23] The City of New York, *New York City 80x50 Buildings Technical Working Group,* 2016, page 6.
[24] The City of New York, *OneNYC: The Plan for a Strong and Just City,* 2015, Page 122.
[25] U.S. Department of Energy, *Energy Efficiency in Separate Tenant Spaces- a Feasibility Study,* April 2016, page 2.

on tenant spaces exclude a large portion of potential energy, and thus GHG emissions, reductions.

Multiple barriers exist for tenants to reduce energy on their own without government intervention including cost structures, data availability, and education and awareness. Cost structure is a commonly cited barrier to energy efficiency.[26] The split incentive barrier is an example of this; one party pays for capital improvements to a building and a different party benefits from these improvements. Energy efficiency improvements often are characterized by the split incentive problem. This is because an owner is typically responsible for paying for and deciding on building upgrades, while a tenant is typically responsible for paying for energy bills and deciding on how they use the space.[27] This is seen when a landlord invests in energy efficient lighting in tenant spaces but the tenant reaps the benefit with a lower electric bill. No incentive exists for landlords to invest in efficient technology. Another example of a cost structure problem is that often building owners operate and pay for central building systems such as HVAC systems. This provides no financial incentive for tenants to reduce their usage and energy-conscious tenants are limited in their ability to reduce energy.

Tenants' lack of information on their energy usage is another barrier. Often tenants are not given the data on how much energy they use or are charged a flat rate for energy usage.[28] This provides no incentive or opportunity for tenants to make informed decisions on improvements or alter behavior to be energy efficient.

[26] Ibid., 2.
[27] Ibid., 14.
[28] U.S. Department of Energy, *op.cit.,* 16.

Lastly, a lack of education and awareness leads to tenants that are unaware and uninterested in energy reduction. Market inertia, competing priorities, information overload and financial concerns all contribute to this problem.[29] This has historically prevented adoption of energy efficiency measures by tenants despite the potential benefits.

These barriers can be overcome by government intervention. The New York City government has been successful in reducing building energy use and associated emissions. However its policies are focused on reductions from common areas and base building systems rather than tenant spaces. The "roadmap" to achieve 80% reduction in emissions recognizes this as a missing piece. This same missing piece is seen in the existing literature. Understanding the barriers to building energy reduction as well as mechanisms to overcome these barriers have been topics of research by academics, government officials, and private companies in order to prescribe solutions that will reduce energy within the building sector as a whole. However, few studies provide an understanding of how government is regulating tenant spaces.

[29] Ibid., page 11.

III. Literature Review

Multiple studies list potential mechanisms, both for the public and private sector, to alter energy use in tenant spaces. The U.S. Department of Energy released a report titled "Energy Efficiency in Separate Tenant Spaces- a Feasibility Study" that assesses the multiple barriers in achieving energy efficiency in commercial tenant spaces and existing mechanisms to address them. This study found a variety of potential ways to address these barriers including, 1) submetering tenant spaces, 2) easy comparison of energy efficient technology, 3) recognizing the business case for energy efficiency, 4) low-cost energy simulation models for tenant spaces, 5) improving leasing language and broker engagement, and 6) the creation of a federal tenant space recognition system.[30]

A study by Bird and Hernandez considered what policy options overcome the split-incentive problem, specifically focusing on low-income renters.[31] These policy options include 1) contracts (i.e. green lease, energy efficiency mortgage and on-bill financing) 2) regulation (i.e., green building code, low-income rental mandates) and 3) all-in services (i.e., grants, concierge services). They argue the best policy approach is carefully designed on-bill financing that improves incentives for participants. On-bill financing is a loan model, often administered by the utility company, which provides money for weatherization improvements that are repaid through the utility bill. The study found that optimal policy characteristics include those that promote voluntary action, provide incentives to landlords and tenants, result in savings, and

[30] U.S. Department of Energy, *op.cit.*, 2.
[31] Stephen Bird and Diana Hernandez, "Policy options for the split incentive: Increasing energy efficiency for low-income renters", *Energy Policy* 48 (2012): 506-514.

exhibit transparency. The study concluded that carefully designed on-bill financing schemes can balance the priorities of all participants.

A study by McKinsey titled "Unlocking Energy Efficiency in the U.S. Economy" quantified the energy and economic losses from inefficiency in buildings and assessed market and policy mechanisms that could lead to greater efficiency. Across the entire U.S. economy, if all of the energy efficiency measures it compiled were executed at scale, it would yield an estimated gross energy savings of more than $1.2 trillion, reducing end-use energy consumption in 2020 by 9.1 quadrillion BTUs, roughly 23 percent of projected demand, and abating up to 1.1 gigatons of greenhouse gases annually. [32] These savings are split between building sectors: 35 percent savings in residential, 40 percent in industrial and 25 percent in commercial.[33] The study argued for four broad categories of solutions to address the barriers: 1) Information and education, 2) incentives and financing, 3) codes and standards, and 4) third-party involvement.

A number of studies seek to specifically understand government policy options, rather than private sector interventions. Innovation Network for Communities and Bloomberg Philanthropies jointly released a report titled "Leadership by U.S Cities: Innovations in Climate Action" that outlined four strategic levers for system change that cities can employ to reduce GHG emissions. [34] A strategic lever is one that can shift a system dramatically to transform its climate-related performance. These include 1) encouraging voluntary action, 2) sending price signals, 3) making public investments, and 4) mandating change.

[32] McKinsey & Company, Unlocking Energy Efficiency in the U.S. Economy, 2009, page 1.
[33] Ibid., 2.
[34] Innovation Network for Communities, *Leadership by U.S. Cities: Innovations in Climate Action,* March 2016.

A report titled "Urban Efficiency: A Global Survey of Building Energy Efficiency Policies in Cities" is a resource for city officials that compiles and provides details on building energy efficiency policies in key cities participating in the C40 program.[35] The report focuses on all actions that local governments are taking to reduce energy use in buildings including 1) building energy codes, 2) reporting and benchmarking of energy performance data, 3) mandatory auditing and retrocommissioning, 4) emissions trading schemes, 5) rating and performance labeling, 6) financial incentives, 7) non-financial incentives, 8) awareness raising programs, 9) promoting green leases, 10) voluntary leadership programs, 11) government leadership and 12) other. Trencher et al. utilized this report and expanded upon it by updating data as well as including original analysis of data. The study consolidates actions into six policy models, including both mandatory and voluntary policies, and identified the unique impacts and challenges accompanied by each.[36] Mandatory policy models included benchmarking, energy auditing/retro-commissioning, energy efficiency standards, and cap-and-trade. Voluntary policy models included capacity building and friendly competition. However, these various studies do not look specifically at tenant spaces.

Iwaro documented building energy regulation in the developing world.[37] The study sought to understand what energy standards currently exist, how those standards were created and implemented and the accompanying effects. This research showed that 42% of emerging developing countries surveyed have no building energy standard in place, 20% have mandatory programs, 22% have mixed programs and 16% have only proposed standards. In general,

[35] T. Takagi, et al., op. cit.
[36] G. Trencher, et al. "Innovative policy practices to advance building energy efficiency and retrofitting: Approaches, impacts and challenges in ten C40 cities." *Environmental Science and Policy* (2016)
[37] Joseph Iwaro and Abraham Mwasha, "A review of building energy regulation and policy for energy conservation in developing countries", *Energy Policy* 38 (2010): 7744-7755.

progress has been made increasing government involvement in energy regulation, number of proposed standards, level of implementation and upgrading of some energy standards from voluntary to mandatory. A study by Baek assessed if existing building energy policy in Europe is applicable in a Korean context.[38] It found that policies that could be implemented in Korea to reduce energy use in existing buildings include building energy performance certification systems, financial support, and supply of information on building energy performance.

The chart (Figure 1) below summarizes the policy mechanisms that are recommended in the previously mentioned studies. The mechanisms at the top were mentioned more than those at the bottom and are thus ones that might be more important in this research. However, it is noteworthy that all are mentioned frequently and should all be considered as relevant policy options.

Figure 1. Policy Mechanisms found in Literature Review

Policy Mechanisms	U.S. Department of Energy	Bird and Hernandez	McKinsey	Takagi/ Trencher	Iwaro
Financial Incentives		x	x	x	
Information and Education through Submetering, Auditing and Benchmarking, Modeling, Performance Certification)	x			x	x
Regulation through Building Codes, Standards, etc.		x	x	x	
Financing		x	x		x
Non Financial incentives		x		x	
Voluntary Leadership	x			x	
Recognizing the Business Case for Energy Efficiency	x	x			
Improving Leasing Language and Broker Engagement	x	x			
Government Leadership				x	
Emissions Trading Schemes				x	

Methodological approaches in these studies were similar to one another, consisting of document review, interviews, and case studies. Case studies of policy, technological and

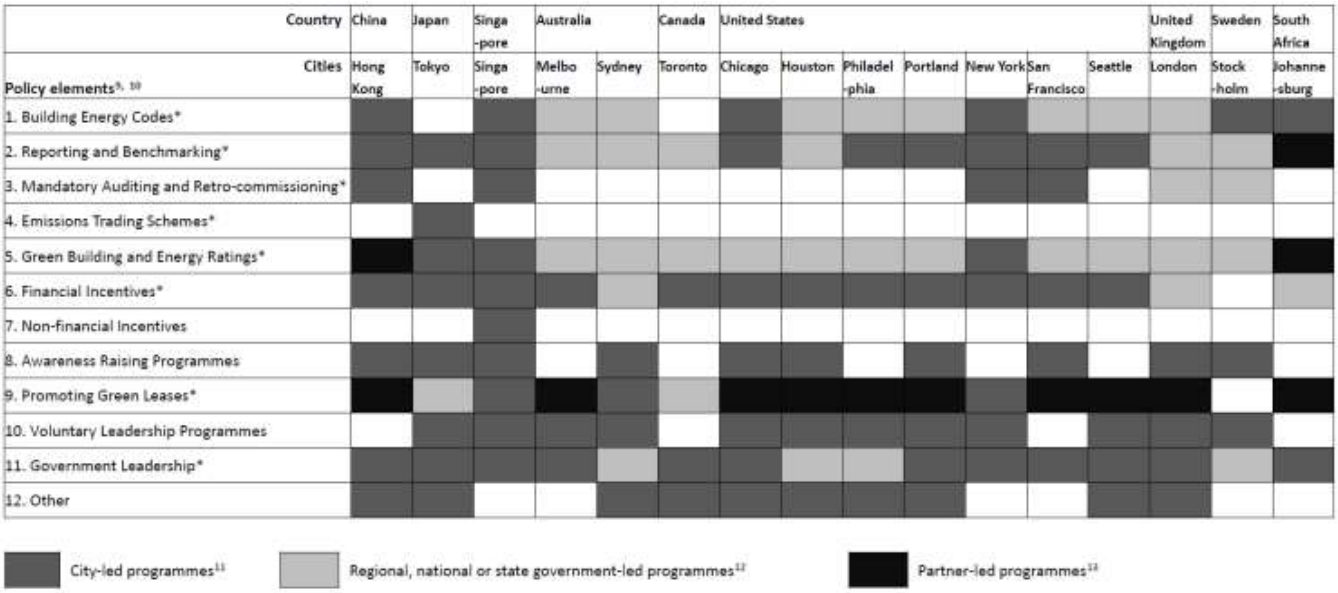
[38] Cheonghoon Baek and Sanghoon Park. "Policy measures to overcome barriers to energy renovation of existing buildings", Renewable and Sustainable Energy Reviews 16 (2011): 3939-3947.

market-based approaches from all over the world were compiled and analyzed in multiple studies (US Department of Energy 2012, Baek 2011, Trencher 2016, Iwaro 2010, Takagi 2014). Data were gathered by reaching out to professionals in multiple ways. DOE gathered information from industry experts and solicited public input in order to gain a comprehensive understanding of the energy efficiency policies for tenant spaces. [39] Baek conducted interviews with academic researchers, NGO staff and government officials in European countries to gather existing policies related to building energy. [40] Trencher and Takagi utilized written questionnaires, semi-structured telephone conference interviews and document analysis to compile information on policies from the C40 cities. [41] Iwaro utilized an online survey sent to contacts in government research organizations and professionals to gather data on existing policies and implementation successes.[42]

The compiled case studies were analyzed in similar ways to understand their application to the specific situation being studied. DOE (2012), Bird (2012), and Trencher (2016) systematically aligned policy options that would address each potential barrier to energy reduction. Citing economic theory and interview data, the studies highlighted the action necessary to overcome each barrier. Takagi created "policy maps" (Figure 2) to provide a high-level overview of the different policies being employed, as shown in the image below.[43]

[39] U.S. Department of Energy, op. cit.
[40] Cheonghoon Baek and Sanghoon Park, op. cit.
[41] G. Trencher, et al., op. cit.
[42] Joseph Iwaro and Abraham Mwasha, op. cit.
[43] T. Takagi, et al., op. cit.

Figure 2. Policy Map[44]



Additionally, Takagi draws on the policy maps and case studies to analyze common lessons and key trends including key characteristics, inputs during design and implementation phase, results and impacts, success factors, key challenges, and future perspectives.

[44] T. Takagi, et al., op. cit.

IV. Research Design

The aim of this research was to understand the approach that local governments have utilized to influence energy use in tenant spaces through both mandatory policies and voluntary programs. Additionally, this research aimed to understand the impetus and barriers to policy creation and implementation regarding private tenant spaces. New York City was used as a case to understand why these policies are important to climate change mitigation, what the city has implemented thus far, and why more has not been done. This approach was taken because New York City has publically recognized energy use in tenant spaces as a weak point in its existing policies and expressed a desire to pursue such policies and programs. This study utilized two research methods: 1) review policy documents such as legislative records, policy statements and government reports as well as 2) perform interviews with selected city officials and industry experts.

Scope

The research drew on policies of city and local governments across the globe. The study was limited to local government because this is the typical avenue through which building level policy is enacted. Local governments often control building codes and other building regulations, the mechanisms through which energy efficiency improvements are often mandated. Also environmental policy and climate change mitigation policy is more likely to get passed on a local level in the United States than at the state or federal level in the current political climate. The scope was global in order to not limit the possible solutions that can be

gleaned. Similarly, both residential and commercial buildings were assessed as to not miss possible solutions.

Research Sample

I compiled policies from cities participating in the C40 program, specifically within the Private Building Efficiency Network. C40 is a global network of cities committed to addressing climate change.[45] Local government representatives within the program collaborate to create innovative and aggressive outcomes for climate mitigation. The C40 program has cities divided in sub-groups by initiatives and networks based on common challenges. The Private Building Efficiency Network, one subgroup of the C40 network, contains 23 cities. I focused on these cities because they are pursuing innovative energy policies for private buildings.

Compilation of Policy Documents

Policies and programs were compiled from the sample cities. Only those that met certain criteria were considered. The criteria were 1) policies where the responsibility for the action was on the tenant to comply with the regulation or 2) programs administered by local government to provide additional resources to tenants to help them reduce their energy use. There were many policies and programs that address energy use in buildings, however only those that met the criteria were included in the research. For example, many policies affect tenant spaces, such as submetering requirements in tenant spaces, however these were not included if the responsibility fell on the building owner to comply.

Legislative records, policy statements and related documents were collected from city websites. Relevant case studies performed within sample cities were also collected. Specific

[45] C40 Cities, *About*, http://www.c40.org/about, (accessed January, 27, 2017).

data included details on the goals and terms of the policy. Measures of program impact were also useful. This includes quantitative data on the participation rates, energy and GHG savings, and compliance rates. Some governments report this data in periodic reports. Background and context surrounding the policy, such as market, technological and political conditions, were valuable as well. This information was in some cases included in periodic reports, press releases and news reports. However, much of this information was not available publically and was gained from interviews.

The policy documents were collected mainly through website review, looking specifically at department sections with key words such as: sustainability, planning, buildings, tenant spaces, energy, and climate.

Interviews

Based on the document compilation, interviews were conducted with city representatives from cities that have policies that focus specifically on tenant spaces and are most relevant to the study.[46] I contacted city representatives through emails that were listed in reports or on city websites.

Interviews were used to understand the context and background surrounding the policy. This information was important to understand why the policy was created, its content and barriers or challenges in implementation.

Interviews were conducted over e-mail. Two city representatives and one policy expert were interviewed. Questions asked included: 1) why was this policy created? 2) What were the challenges (legal, social, political, technological, etc.) in designing or implementing the policy?

[46] I received Columbia University Institutional Review Board approval to conduct interviews with these professionals in November 2016.

3) How were stakeholders involved in crafting the policy and what has their reaction been? (See Appendix A).

An interview was also conducted with an official from the New York City Mayor's Office of Sustainability to understand the existing barriers to implementing policies on tenant energy use. Questions asked included: 1) what are the challenges (legal, social, political, technical, etc.) to designing and implementing a policy on tenant energy use? 2) Are there non-government or government programs and projects that are currently working to address this issue through a non-policy approach? 3) What barriers did the other climate policies that focused on buildings (LL84, 87, 88) meet? (See Appendix A). Interviewees were also asked to provide additional information or points of contact that they believe would be helpful in this study.

V. Findings and Analysis

Summary

While there is consensus among experts and city representatives that this is a common and complex problem, there is no consensus as to how to best respond. A multitude of barriers exist leading most approaches to focus on other aspects of building energy use. Both recognizing this unregulated use of energy as a problem and understanding the barriers that exist in regulating it are crucial steps to provide context and lessons for other cities looking to advance change in this area.

Cities are attempting to influence energy use in tenant spaces in a variety of ways. Few mandatory policies were found within sampled cities. Most cities provide a multitude of programs that foster the voluntary reduction of energy use in tenant spaces by providing resources, opportunities, and incentives to tenants. The most common of these programs is providing educational resources and green leasing assistance. No silver bullet was revealed that needs to be adopted and implemented in cities across the globe.

The main barrier that New York City policy makers face in creating policy that impacts tenant energy use is a lack of legal authority over tenants' private space. This had led policy makers to rely mainly on voluntary programs. Two programs by New York City, Tenant Star and the Carbon Challenge for Commercial Owners and Tenants, aim to overcome common barriers faced by tenants and owners in achieving energy efficiency in tenant spaces. The programs provide platforms for both owners and tenants to communicate their desire for energy efficiency and scale up the demand on the market for efficient spaces.

The following sections provide details on each of these main findings.

Problem Recognition

Interviews with city representatives and experts in the field reveal that the challenge of regulating tenant energy use is a commonly recognized problem. These findings reinforce those from Takagi's study, *Urban Efficiency,* where a majority of city officials who participated acknowledged that regulating tenant spaces was one of five particularly challenging issues. A scholar who has conducted multiple studies on this issue stated that city governments take the challenge of regulating tenant energy use very seriously and many city governments in the C40 network wish to tighten their policies and introduce more mandatory measures. [47] He also indicated that more strategies, specifically mandatory policies and policies that target tenants, are needed to meet the aggressive goals set by the United Nations Framework Convention on Climate Change at the 2016 Paris Conference of Parties.

Interviews also revealed that local governments are concerned about tenant energy use. Melbourne has utilized citywide energy use data to showcase that tenant energy use is a large contributor to citywide emissions. Commercial buildings represent more than 50% of Melbourne's emissions with tenants controlling half of those emissions.[48] The city created the CitySwitch program in recognition of this segment of energy users that need to be targeted to reach emissions reduction targets. The city representative of Melbourne stated that because

[47] Interview with Gregory Trencher, March 18, 2017.
[48] Interview with City of Melbourne representative, March 15, 2017.

the city is limited in its legal control over many types of emissions, "every emissions source is seen as both a challenge and an opportunity for creative problem solving".[49]

The City of Boston also expressed concern over this issue. A city representative stated that there is a particular interest in accelerating participation from new audiences, including renters.[50] One of the City of Boston's priorities in its 2014 Climate Action Plan Update was to expand energy efficiency programs through targeted outreach to renters, low-income populations, and multi-family buildings and to empower residents and businesses to take action, specifically mentioning solutions to landlord-tenant split incentive.[51] The city recognizes the need to target programs towards certain market segments which have been underserved or ignored in the past.

These findings showcase this issue as a perplexing, universal issue. This is an important first step in advancing change in this segment of energy use. If cities needed to be convinced that tenant energy use was a problem, the approach to reducing tenant energy use would need to take this into account.

Policy Patterns

The policy map, shown below in Figure 3, provides an overview of the policies and programs being employed by the sample cities that influence tenant energy use. It is organized to show the policies or programs employed by most cities on the left and those by the fewest cities on the right.

[49] Interview with City of Melbourne representative, March 15, 2017.
[50] Interview with City of Boston representative, March 19, 2017.
[51] City of Boston, *Greenovate Boston 2014 Climate Action Plan Update*, 2014.

Figure 3. Policy Map of Tenant-Specific Policies and Programs

Policies and programs were classified into five categories of regulation type. These categories are: Capacity Building/Incentives, Friendly Competition, Emissions Trading Schemes, Energy Efficiency Standards, and Disclosure and Understanding of Energy Information. The first three are mandatory regulations and the latter two are voluntary programs. The categories were based on the six policy models identified in Trencher et al.'s study. [52] Figure 4 provides definitions of the policies within each category, adapted from Trencher et al.:

[52] G. Trencher, et al., op. cit.

Figure 4. Category Definitions

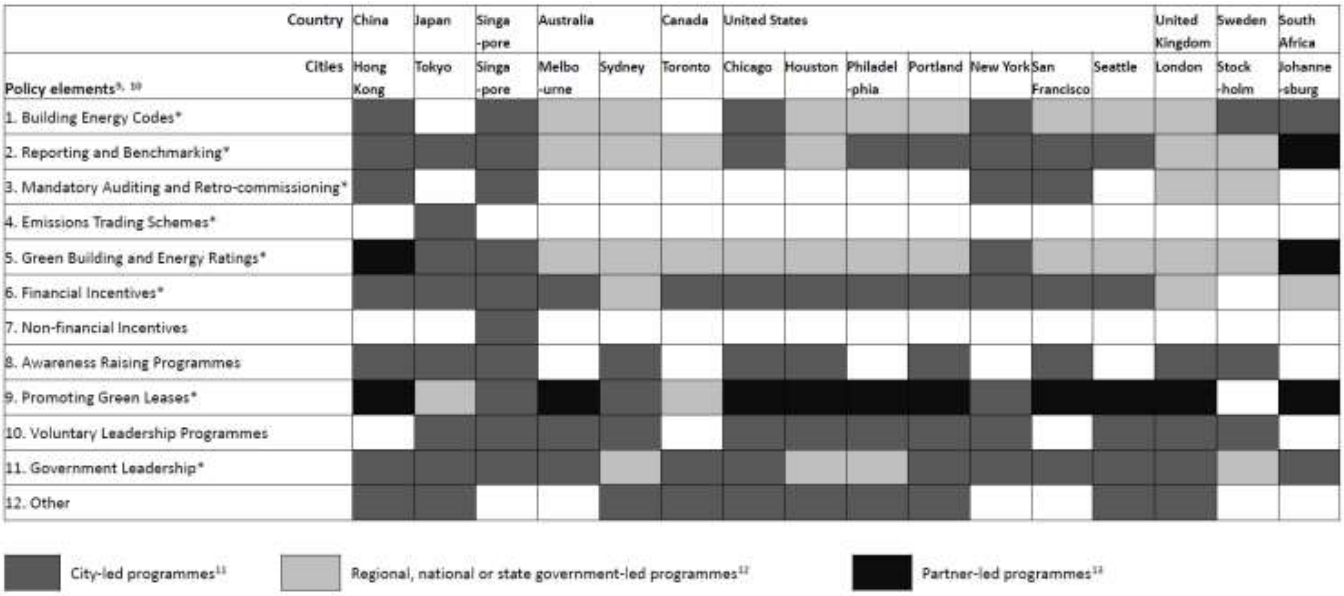
Type		Description
Mandatory	Disclosure and Understanding of Energy Information	Mandates submetering, auditing, retro-commissioning, energy benchmarking, or performance certification.
	Energy Efficiency Standards	Mandates minimum energy efficiency standards when replacing or renovating specified building components
	Emissions Trading Schemes	Mandates achievement of minimum GHG emission reduction targets for individual buildings via internal actions or trading of emissions credits
Voluntary	Capacity Building/ Incentives	Fosters voluntary reduction of energy consumption by offering incentives and information such as access to best practices, broker engagement, technical support, financing and public recognition
	Friendly Competition	Fosters significant reductions of energy consumption over a short time period in a cohort of buildings and tenants competing to outperform each other

The policy map reveals patterns within the types of policies that the sample cities employed. The policy map from Takagi's study, shown in Figure 5 below, includes policies and programs that influence energy use in private buildings, including both common and tenant space, and where the responsibility falls on owners and tenants.[53] Conversely, the policy map from this research only includes those policies where the obligation falls on the tenant or programs from which the tenant is receiving additional resources to reduce energy usage. Juxtaposing the policy map in Figure 3 to the policy map from Takagi's study reveals that there

[53] T. Takagi, et al., op. cit.

is a considerable amount of action that has been taken that regulates energy use in buildings (shown in Figure 5); however few focus on tenant action or tenant spaces (shown in Figure 3). This imbalance is seen for example when examining the category of "Disclosure and Understanding of Energy Information" in Figure 3, which correlates to Takagi's categories 1, 2, and 3. Eleven cities in Takagi's study have relevant policies within these categories. However there are no tenant-specific policies. This juxtaposition of policy maps reinforces the findings within the literature that tenant-specific policies are lacking.

Figure 5. Policy Map from Takagi Report



One commonality between the policy maps is a plethora of policies and programs that fall under "Capacity Building/Incentives", represented within Takagi's categories 6 to 12. (This abundance of policies and programs will be discussed in more detail later.)

Another main finding is that there are more voluntary programs than mandatory policies. Only two cities have mandatory policies that regulate tenant energy use. This is in contrast to 18 cities that have voluntary programs.

The mandatory policies fall into the categories of Emissions Trading Schemes and Energy Efficiency Standards. The policy under Emissions Trading Scheme is the Tokyo Cap-and-Trade program (TCTP). The Tokyo Metropolitan Government implemented the TCTP in 2010, targeting large commercial and industrial buildings that consume more than 1500 kL of crude oil equivalent.[54] Tenants who occupy a large area of building space, 5000 m^2 or greater, or consume more than 6 million kWh of electricity per year must participate in the program. Buildings are required to reduce GHG emissions by a certain percentage within a 5 year cycle. If they are unable to meet the target, building managers or owners must purchase external carbon credits for that year. Excess credits can be traded with other facilities in TCTP or a variety of similar sources. This process repeats each year during the 5 year compliance cycle. If at the end of the cycle the target has not been met, a building must purchase additional offsets credits and face a large fine.

The facilities mandated to comply through the program represent 0.2% of all buildings within the commercial and industrial sectors in the city. These buildings account for 40% of CO^2 emissions from these sectors.[55] TCTP's inclusion of tenants in its scope signifies the importance of targeting the largest contributors to GHG emissions regardless of ownership type. Additionally, by only including those tenants that are large consumers, the municipal

[54] T. Takagi, et al., op. cit.
[55] Ibid.

government uses its resources most effectively to reduce GHG emissions by avoiding many implementation challenges that would likely exist if the scope included all buildings.

The other mandatory policy in place is Hong Kong's Building Energy Efficiency Ordinance. One requirement of this legislation is that "responsible parties" must ensure that certain equipment complies with the specific energy efficiency standards when they complete retrofit projects.[56] "Responsible parties" is defined as whoever is undertaking the retrofit project, which could include tenants, owners, or occupiers. This regulation impacts installation of air-conditioning, lighting, and electrical and conveyance systems.

The voluntary programs fall into the categories of Friendly Competition and Capacity Building/Incentives. Friendly competition provides a formal platform for both tenants and owners to reduce energy. A main element of many competitions is an opportunity for the city to provide educational resources and trainings tailored to specific groups that guide in reducing energy. An example of a friendly competition is New York City's Carbon Challenge Program. The City launched a Commercial Owner and Tenant Challenge in 2017. Patrick Love, the coordinator for the Carbon Challenge noted the importance of the program to better understand the market and as a platform to test the effectiveness of messaging, build relationships and provide proof of concept that can be helpful in creating other policies in the future.[57] It is too soon to

[56] Hong Kong Environment Bureau, Development Bureau, Transport and Housing Bureau, *Energy Saving Plan: Hong Kong's Built Environment 2015-2025+,* May 2015.
[57] Interview with Patrick Love, November 15, 2016.

measure or determine program impact; however enthusiasm was expressed by both tenants and owners that the program will be helpful to them.[58]

Takagi's report, *Urban Efficiency*, notes that friendly competition has been one of the most successful ways of engaging tenants to reduce energy. The study conducted multiple interviews that revealed that a strong stakeholder process ensured that the design of the program was appropriate and fit the needs and realities facing tenants. Including tenants in the program design led to a "network of advocates" that ultimately led to greater participation.[59]

The other category within Voluntary Programs is Capacity Building/ Incentives. This category has the most policies attributed to it. 17 out of the 23 cities have programs that fall into this category. This category encompasses many different types of programs. To further discern patterns among these programs, Figure 6 looks solely at this category and further classifies programs into different types. These categories are: Educational Resources, Green Leasing Assistance, No-Cost Retrofit Supplies, No-Cost Energy Evaluation, Financial Incentives, and Disclosure of Energy Information. The policy map is organized to show the program employed by the most cities on the left, and those by the fewest number on the right. Figure 7 provides definitions of the policies within each category.

[58] Interview with Patrick Love, November 15, 2016.
[59] T. Takagi, et al., op. cit.

Figure 6. Policy Map for Capacity Building/Incentives Category

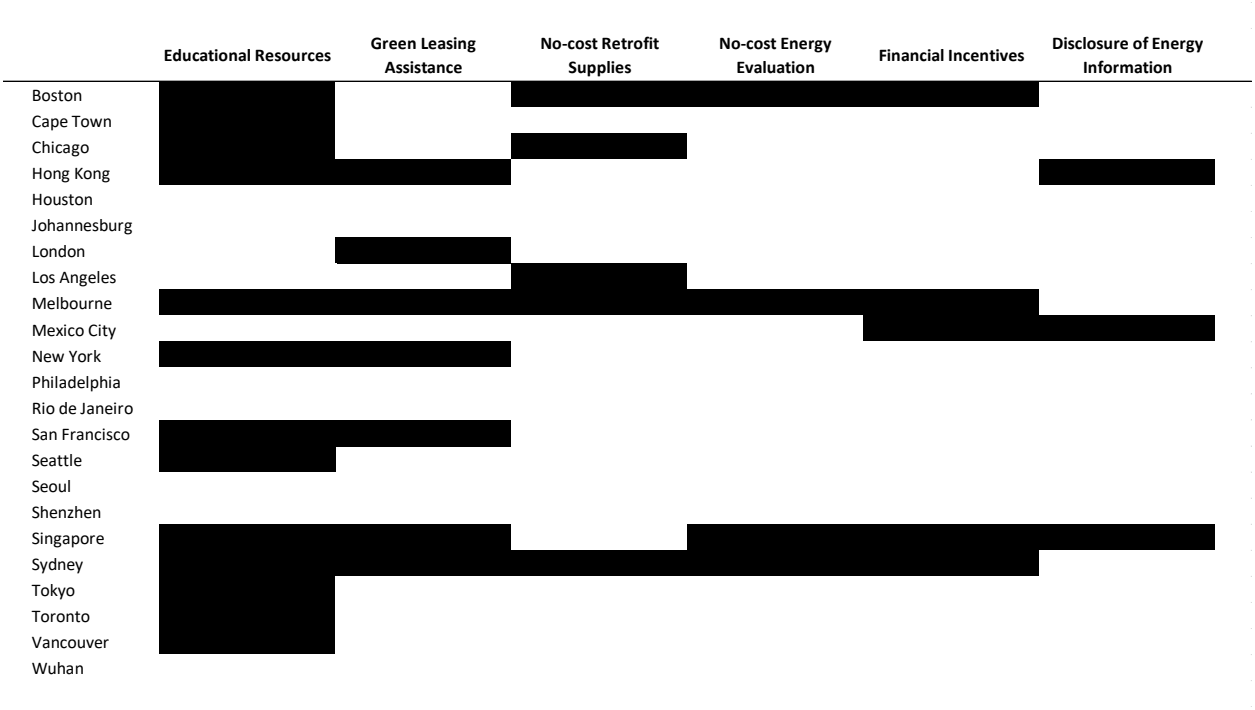


Figure 7. Category Definitions for Policy Map for Capacity Building/Incentives Category

Type	Description
Educational Resources	Provides educational resources such as trainings/tips to learn how to reduce energy use and awareness campaigns
Green Leasing Assistance	Provides best practice guides and sample lease language for tenants and owners/ management to engage in green lease agreements, which align financial and energy incentives for all parties involved
No-cost Retrofit Supplies	Provides tenants with materials and equipment, such as weather stripping and CFLs, to retrofit their spaces
No-cost Energy Evaluation	Provides an energy visit from a certified specialist to help tenant understand the energy use of their space and potential areas of reduction
Financial Incentives	Provides a variety of financial incentives including unique financing structures for retrofit projects, rebates, tax reductions, etc.
Disclosure of Energy Information	Provides Labelling and Performance Certification schemes that inform tenant of the energy use of the space or appliance

"Educational Resources" was the most commonly employed program type. An innovative example is the CitySwitch Program that is run in multiple cities in Australia, including Melbourne and Sydney. CitySwitch seeks to educate and support commercial tenants to reduce their energy use through 1) one-on-one support from a city official, 2) free online resources including toolkits, case studies, and engagement tools, 3) a network of participants to share best practices, 4) regular training events, 5) annual awards for achievement, 6) financial assistance towards the cost of energy ratings and advice on accessing incentives and other

finance options for energy investments, and 7) public promotions that provide a competitive advantage within the building sector.[60] Nationwide, the program has reached a significant number of office tenants, totaling 801 members.

Melbourne and Sydney both have many successful programs that fall within the voluntary categories and none that fall within the mandatory category. This is due to the limited legislative power that Australia affords to cities. Local governments are not legislative bodies, meaning they have control over certain planning issues but mainly state and federal parliament set regulations.[61] A city official from Melbourne noted that "Australian local governments need to work with state and federal governments to advocate for legislative changes and work with industry via partnerships to enable change locally".[62] Because of these limitations in power, the CitySwitch program aims to be a "relevant voice in the market" to "disseminate information about the effect for commercial building tenants of any policy changes and also responds to state and federal governments in the manner of legislative review submissions".[63] These two cities have utilized the power they do have to create a comprehensive program and wide-reaching network of partners to pursue emissions reductions in tenant spaces through education.

The "Green Leasing Assistance" category contains the second highest number of cities with policies in that category. Hong Kong, London, Melbourne, New York, San Francisco, Singapore and Sydney all provide programs to facilitate green leasing practices. The City of

[60] CitySwitch Green Office, *Program Report 2016,* 2016.
[61] Interview with City of Melbourne representative, March 15, 2017.
[62] Ibid.
[63] Ibid.

Sydney's Better Buildings Partnership (BBP) developed a successful green leasing program that has resulted in 62% of all leases in the market containing green lease language.[64] The program created a suite of tools including 1) standard logo to signify that an organization has signed a green lease, 2) BBP Lease Scoring Tool that communicates an organization's willingness to utilize green leasing, 3) BBP Lease Standard Template Clauses and 4) Resource e-books. The City of Sydney also has shown leadership by signing 24 green leases for public buildings.[65] This comprehensive approach to green leasing practices demonstrates the importance of providing targeted resources that are grounded in stakeholder engagement and market research.

A few cities employ programs under the "Disclosure of Energy Information" category. Most building performance certification schemes are conducted on a national or multinational level (i.e. Australia NABERS program, US Energy Star, USGBC LEED). Singapore was the only city that had a voluntary performance certification scheme, GreenMark, to inform tenants of a building or spaces energy use. However due to Singapore's unique political status as a sovereign city-state, the lessons learned from this scheme are possibly not relevant to most cities.

The City of Boston's Renew Boston program provides resources that fit into multiple categories within the policy map. Renters are eligible to receive a no-cost energy visit from a Certified Energy Specialist to help the tenant understand the energy use of their space and

[64] City of Sydney, *City of Sydney Energy Efficiency Master Plan: Improving Energy Productivity 2015-2030,* August 2015.
[65] Better Buildings Partnership, *Annual Report FY2015,* 2015.

potential areas of reduction.[66] This program also provides the renter with no-cost energy-saving equipment, including LED light bulbs, low-flow showerheads and aerators, and efficient power strips. The program partners with MassSave, a state run program, to provide rebates for energy retrofits if both tenants and owners agree to participate together.

The policy maps address how local governments are influencing energy in tenant spaces, the first aspect of this research. There is a clear abundance of voluntary programs, rather than mandatory policies, being instituted. Additionally, they highlight the most commonly utilized programs to reduce energy in tenant spaces providing educational resources and advocating for green leasing practices. These findings provide insights for local governments to understand the variety of existing policies and programs that are available to be implemented within their jurisdiction.

Barriers and Challenges

Five barriers were recognized by interviewees: a lack of legal authority, stakeholder resistance, coordination among multiple parties, diversity among tenants, and resource constraints.

A main barrier was the lack of legal authority for a city to regulate energy use within private spaces. Authority varies greatly between cities. For example, with few exceptions, Melbourne and Sydney cannot enact mandatory policy so have to resort to voluntary

[66] City of Boston Office of Energy and Environment, https://www.boston.gov/environment-and-energy/renew-boston, (accessed March, 15, 2017).

approaches.[67] New York City also cited this as a critical barrier, as will be discussed in additional detail later.

Stakeholder resistance was also a barrier to policy creation and implementation. While many city governments recognize the need to target tenants' energy use to reduce emissions to the necessary levels, often stakeholder and industry groups do not support these policies because they require additional work and upfront costs. Building industry and realtor groups prefer incentives and voluntary agreements.[68] This opposition often politicizes the issue, leading elected officials to shy away from mandatory policies.

Coordination among multiple parties was a commonly cited challenge in policy implementation. There are many complex relationships between tenants, owners, and property managers within each building that can be influenced by a new policy or program. Expanding a policy to include tenants, rather than just owners, significantly increases the number of people involved. Education and awareness campaigns to assist with compliance must reach many more people, with complicating factors such as acquiring contact information and language barriers.[69] Turnover of tenants or changes in owners complicates communication between these parties and the city.[70] Engagement over time is challenging when parties must be reintroduced to the program or policy. Lastly, poor working relationships between landlords and tenants were noted as a barrier to tackling 'whole-of-building' solutions.

[67] Interview with City of Melbourne representative, March 15, 2017.
[68] Interview with Gregory Trencher, March 18, 2017.
[69] Interview with City of Boston representative, March 19, 2017.
[70] Interview with City of Melbourne representative, March 15, 2017.

Drafting a policy for tenants is also challenging due to the diversity within this group, as noted by the city representative of Melbourne. Tenants differ greatly in regards to their energy needs, financial status, etc. between residential and commercial sector. Even within the commercial sector, tenants still "represent a wide variety of different businesses of different sizes in different industry sectors and are motivated by different drivers".[71] Creating policy that is appropriate for all type of tenants poses a challenge.

Lastly, resource constraints among city agencies can limit the feasibility and success of programs. Resources include both funding and full time employees. For example, the CitySwitch program in Melbourne only has one full time employee dedicated to operating the program and managing the interactions with tenants.[72] This lack of resources results in fewer tenants that are able to be assisted and thus fewer energy reduction projects being implemented.

These findings provide an understanding for what limitations might exist for a specific city. Recognizing these barriers help policymakers know what regulations are possible with current conditions, and what needs to change in order to create a specific policy.

New York City's Current Approach

The main barrier New York City policy makers face in creating mandatory policies that impact tenant energy use is a lack of legal authority over tenants' private space. Other barriers, such as those mentioned previously, are not a consideration for New York City policymakers in creating regulations because lack of legal authority trumps those challenges.[73] For example, the

[71] Interview with City of Melbourne representative, March 15, 2017.
[72] Ibid.
[73] Interview with Patrick Love, March 20, 2016.

City is limited in authority to require that leases be constructed in a certain way regarding energy use (i.e. mandate that they include particular clauses) because the City has limited and specific legal authority to intervene in a contractual agreement between the owner and tenant, two private parties.

For this reason, New York City has created policies that put the onus of compliance on the owner of the building. This is based on legal authority vested in the Commissioner of the Department of Buildings by the New York City charter.[74] Many of these policies were discussed in the Background section.

Two new approaches New York City is utilizing to influence tenant spaces is the Carbon Challenge Commercial Owner Tenant Program, launched in 2017, and the Tenant Star program, which is currently in an early planning phase. As detailed earlier, the Carbon Challenge provides a platform for owners or tenants interested in energy efficiency to approach the other party. Owners do not often want to approach tenants to discuss energy efficiency. They prefer to only answer to tenant demands because their main concern is to have the space filled to receive rent income.[75] The Carbon Challenge affords the opportunity for owners to approach tenants with support from the City, which has shown to be an effective method.

The Tenant Star program addresses the demand of the tenant who wishes to pursue energy efficiency within their space.[76] The Tenant Star program is modelled after the US EPA's Energy Star. It will allow tenants the opportunity to generate a simple metric to define the

[74] The City of New York, Local Law 87.
[75] Interview with Patrick Love, March 20, 2016.
[76] Ibid.

energy efficiency of their space to compare their space to similar firms. For example, a marketing firm in Midtown can see how their space performs compared to other marketing firms in the area. A New York City official stated that this approach of providing standard, common language to tenants to understand energy in their space assists tenants in demanding more efficient spaces from landlords.[77] There is no straight-forward way for tenants to request more efficient spaces from owners. More sophisticated tenants, such as corporations that occupy a large portion of a commercial building, are asking for certification systems like LEED-CI, Living Building Challenge, and WELL. However, this model has not reached the general market. US Environmental Protection Agency plans to implement Tenant Star nationwide starting in 2022. New York City aims to unroll a city-specific Tenant Star program before the nation-wide rollout. The two new programs created by New York City provide a platform to create demand for energy efficient tenant spaces from both the owner and tenant side.

These findings highlight New York City's commitment to pursuing voluntary programs that influence tenant energy use in order to reduce emissions from a large energy user. Pursuit of voluntary programs acknowledges the limit on the city's legal authority while also accomplishing its goals.

[77] Interview with Patrick Love, March 20, 2016.

VI. Recommendations

The following list consists of recommendations for city policy makers when considering how to reduce energy use in tenant spaces.

1. *Design interventions based on city-specific barriers and opportunities*

As shown in the Findings and Analysis section, there are a variety of policies and programs that address energy use in tenant spaces that warrant replication or implementation on a larger scale. Understanding the current limits and opportunities within the local government is the first step to design interventions that are feasible and effective. For example, policy makers in New York City recognize that the main barrier to regulating tenant energy use is lack of legal authority. The first question that would need to be answered before creating a regulation is what structures can be put in place that would make a mandatory requirement legal in New York City? Utilizing case studies and sharing best practices and best policy models is an effective tool if policy makers acknowledge the specific limits and opportunities their city faces to determine the feasibility of various approaches. There is no one best policy that must be implemented in all cities. Good judgement by policy makers must be used when implementing approaches based on the city's specific situation.

2. *Design policies and programs that target the largest energy users*

Policy creation and implementation can be simplified and strengthened by focusing on the largest energy users rather than attempting to regulate the entire market. A common approach is to regulate the building sector that uses the most energy (i.e. industrial or commercial). Another approach is to require compliance by buildings that use over a certain

amount of energy. Both of these approaches were utilized in Tokyo's Cap-and-Trade Program. By targeting only the largest users in the commercial and industrial sectors, the government was able to implement a successful program that impacts a majority of GHG emissions while simultaneously encountering fewer implementation challenges such as political and stakeholder resistance. Additionally, fewer governmental resources (employee time, money, etc.) are required to implement the program.

3. *Utilize case studies and pilot programs to justify bold action*

One commonly cited barrier was that politicians are often unwilling to make legislation that has the potential to severely upset or hurt the relationship with stakeholder groups like building owners or the real estate industry. One way to overcome this is by providing examples of success through pilot program implementation and case studies. New York City's Carbon Challenge uses this approach to provide justification and act as proof of concept for the creation of additional climate policies and programs. Carbon Challenge participants are a captive and willing audience to test many energy reduction strategies, including not only building technologies but also other important factors that affect energy efficiency in tenant spaces. For example, policy makers are able to better understand the complex relationship between landlord, tenant, and property management companies at different points during the leasing phases which can inform future avenues for policy. Another example where this was successfully implemented was Boston's financing scheme, Whole Building Program, which was piloted in Boston in June 2013 and was launched state-wide in Spring 2016. Continued research

by organizations like C40 that provide detailed case studies will also be beneficial in providing justification for political leadership to take bolder climate action.

4. *Explore options to scale-down policy models typically implemented on state and national level*

By expanding the scope of research to include state or national level approaches, unique solutions can be scaled for city-level application. Policies and programs that are typically implemented on a state or national scale can be altered to fit within the authority and budget of a city. Both Singapore's Greenmark certification program and Tokyo's Cap-and-Trade Program are policy models that are usually implemented on a regional or national scale however were successfully implemented on a city-scale. Policy makers should consider this scale of policy as examples to inform city-level policy.

In addition to the recommendations that are geared towards policy makers, further research on policy effectiveness is also recommended. Analyzing the effectiveness of the policies in the policy maps was outside the scope of this study. Future study of this issue by researchers in the field is advised because this information will significantly help policy makers when deciding if replication of a policy or program is warranted. The majority of these policies are relatively new and thus data is not abundant and easily accessible. Determining what data exists, as well as how to access this data, will be a key component of this work.

Further research on the legal and regulatory authority of specific city governments is also warranted. While many city representatives noted that their city did not currently have

authority to regulate energy use within private tenant spaces, precedent exists for local government to regulate activity within those spaces. Future study of the legal aspect of this question will determine if legal authority is a real or perceived barrier, and what steps can be taken to overcome it.

VII. Conclusion

Policy makers and experts agree that reducing energy use in tenant spaces is a significant part of achieving GHG emission reductions to mitigate climate change. This research provides context and lessons for policy makers looking to advance change in this segment of building energy use. The policy maps provide examples of approaches taken and also highlight where opportunity exists for innovative, new regulation and policy types. Currently, local governments' main tool to influence these spaces is through voluntary programs, largely by providing educational resources to tenants and green leasing assistance. Few mandatory policies are in place due to a multitude of barriers. Understanding the barriers that exist within a specific city reveals what changes are required to pursue a certain policy or program and which action will be most appropriate.

In order to successfully influence tenant energy use, policy makers should design interventions based on barriers and opportunities present within that specific city. New York City's public acknowledgement of influence on tenant energy use as a weak point in its existing policies highlights the potential that exists for innovation to target a new segment of the market. By understanding the limits on the city's legal authority, policy makers crafted two new programs that effectively allow them to pursue their goals within existing legal frameworks. Knowledge sharing between cities is a particularly valuable tool when lessons are paired with an understanding of city-specific opportunities.

City governments must continue to pursue action to target reduction of energy use in tenant spaces. City-level action is crucial in the curbing climate change due to the proportion of

emissions associated with cities and city governments' political and practical capacity to make necessary changes.

While many governments have created policies focusing on reducing energy and emissions from buildings, additional work is needed in focusing on tenant spaces. Knowledge sharing between governments and intervention design based on city-specific barriers and opportunities will enable policy makers to craft effective policies and programs to address the largely untapped potential that exists to reduce energy use within building tenant spaces.

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Appendix A. Interview Schedules

Interview with city representatives

Evidence	Questions
Impetus for policy	Why was this policy created? What context surrounded the creation of this policy? What did this policy set out to accomplish and why?
Policy design	What were the challenges in designing the policy? What determines if a policy is mandatory or voluntary?
Policy characteristics	Can you describe how the policy works? How is it experienced from the tenant, owner and city?
Policy implementation	What are the challenges in ensuring compliance? What were the challenges in passing the policy through legislation?
Stakeholder reactions	How did stakeholder views play a role in policy design? How have stakeholder views changed since implementation?

Interview with building energy policy expert

Evidence	Questions
Impetus for policy	How is the problem of regulating tenant energy use viewed by governments and policymakers? Is it a common issue that is often brought up as a barrier to GHG reductions? Is there a view that it is a role for governments or for private market?
Policy design	The majority of the policies and programs that I've found are voluntary programs that assist tenants in reducing energy usage in their space- or mandatory policies where the obligation falls on the owner. Can you provide any insight into why this is the case? Do you think mandatory policies that fall on the tenant are needed in order to reach lofty climate goals set by many cities/countries/Paris Agreement?

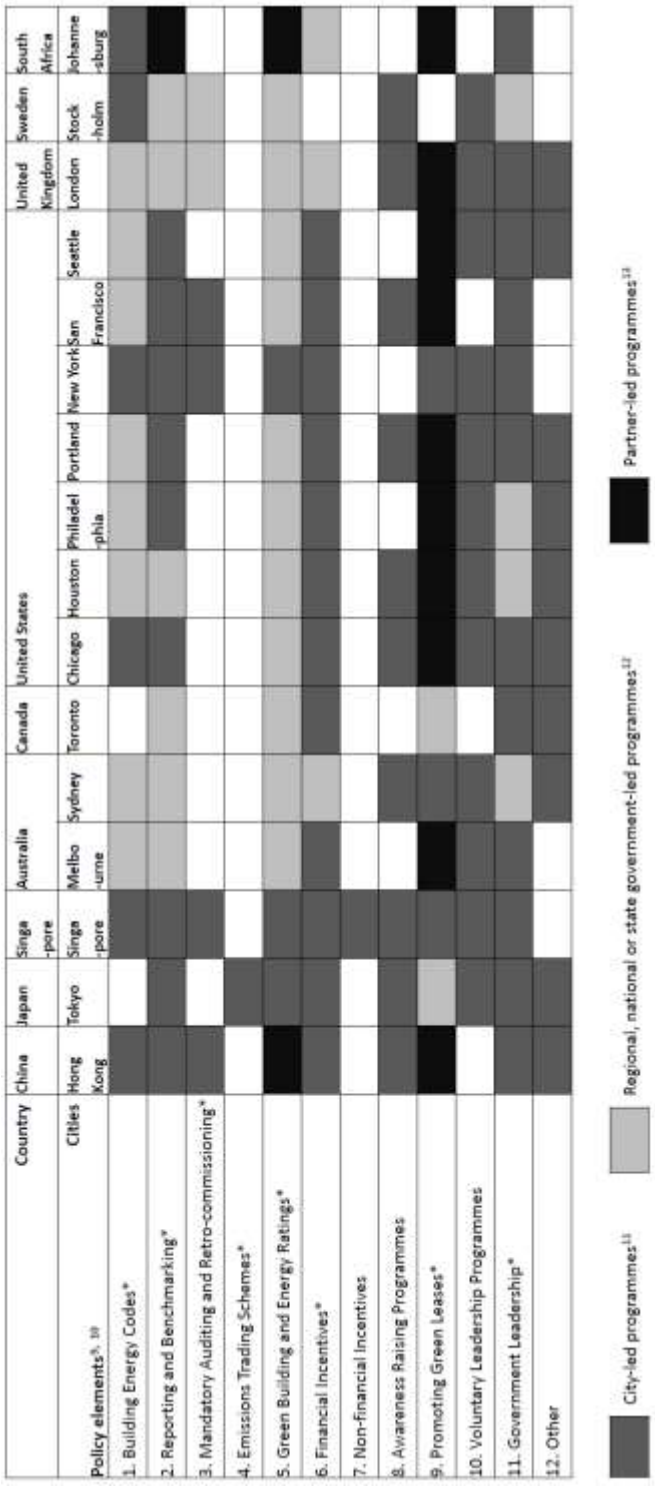
Interview with New York City representative

Evidence	Questions
Barriers and Challenges to policy creation and implementation	What are the challenges to designing and implementing a policy on tenant energy use? Legal, social, political, technical, etc. What barriers did the other climate policies that focused on buildings (LL84, 87, 88) meet?
Policy design	The majority of the policies and programs that I've found are voluntary programs that assist tenants in reducing energy usage in their space- or mandatory policies where the obligation falls on the owner. Can you provide any insight into why this is the case? What would elevate the issue to create mandatory policies?

Appendix B. Detailed Policy Map

City	Providing Information to Users	Energy Efficiency Standards	Emissions Trading Schemes	Capacity Building/ Incentives	Friendly Competition
Boston				1- Greenovate Boston-educational resources; 2- Renew Boston-no-cost energy evaluation, no-cost retrofit supplies, financial incentives	
Cape Town				Smart Living and Working Program and Electricity Savings Campaign- educational resources	
Chicago				1-Education and Weatherization Program- no-cost retrofit supplies, educational resources; 2- Awareness campaign-educational resources	Challenge program
Hong Kong		Building Energy Efficiency Ordinance		1- BEAM Plus Interiors- Disclosure of Energy Information; 2-Green Tenancy Driver for Office Buildings- Green Leasing Assistance and Educational Resources	
Houston					Challenge program
Johannesburg					
London				1- Green lease toolkit- Green Leasing Assitance	Challenge program
Los Angeles				No-cost Retrofit Supply through LA Library Program	
Melbourne				1- Green lease toolkit- Green Leasing Assistance; 2- CitySwitch-no-cost energy evaluation, no-cost retrofit supplies, educational resources; 3- Environmental Upgrade Agreement-Financial Incentives; 4- Rebate for NABERS tenant energy rating- Financial Incentives	
Mexico City				Sustainable Buildings Certification Program- Financial Incentives; Disclosure of Energy Information	
New York				1- GreeNYC- Educational Resources; 2- Energy Aligned Lease Clause (2011)- Green Leasing Assistance	Carbon Challenge
Philadelphia					
Rio de Janeiro					
San Francisco				1- Green Tenant Toolkit- Green Leasing Assistance, Educational Resources	
Seattle				Seattle 2030 Eco-District- Educational Resources	
Seoul				Building Retrofit Program Loan Support Scheme- Financial Incentives	
Shenzhen					
Singapore				1- Green Mark Incentive Scheme- Financial Incentives; 2-Green Lease Toolkit- Green Leasing Assistance; 3- Green Mark program to certify smaller spaces- Disclosure of Energy Information; 4- Green Partnership Initiative Programme-Educational Resources, No-cost energy evaluation; 5- Green Mark- Disclosure of Energy Information	Green Mark Pearl Award
Sydney				1- Better Buildings Partnership- Green Leasing Assistance; 2-Smart Green Apartments program- no cost energy evaluation; 3- CitySwitch- no-cost energy evaluation, no-cost retrofit supplies, educational resources; 4- Environmental Upgrade Agreement- Financial Incentives; 5- The Green Living Centre-Educational Resources; 6- Smart Green Business- Educational Resources	
Tokyo			Tokyo Cap-and-Trade Program	Energy Resource Guidebooks	
Toronto				Live Green Toronto Program- Educational Resources	
Vancouver				Empower Me- Educational Resources	
Wuhan					

Appendix C. Takagi et al. Policy Map [78]



[78] Takagi, T. et al., *Urban Efficiency: A Survey of Building Energy Efficiency Policies in C40 Cities*, 2014.